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(54) Overlay coating.

(57) A method of producing an overlay coating on a substrate such as a turbine blade which comprises: (1) plating a protection layer comprising a metal matrix M_1 containing particles of $CrAlM_2$, (2) plating an anchoring layer comprising a metal layer containing larger particles, and (3) spray coating a thermal barrier of a refractory material.

EP 0 288 156 A1

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OVERLAY COATING

This invention relates to the provision of overlay coatings incorporating thermal barriers on substrates. Such overlay coatings are employed on components which are subjected to high temperature environments, particularly where corrosion and/or erosion is likely to occur; the primary, but not necessarily sole, application of such coatings is to parts of gas turbine engines, particularly gas turbine combustion can ware, stator and rotor blades and guide vanes.

It has been proposed to produce an overlay coating by first spray coating on to a suitably prepared substrate surface a protection layer of MCrAlY (where M is a suitable metal such as nickel or cobalt or nickel and cobalt) using a plasma deposition process, then spray coating an anchoring coat of a metal by a flame deposition process which produces in the deposit substantially coarser particles than those in the protection layer, and then spray coating a thermal barrier of a refractory material by a plasma deposition process.

While this procedure is, in general, satisfactory there are certain aspects of it which are not ideal. For example, the flame spraying of complex and re-entrant surfaces can be difficult and expensive.

According to the present invention an overlay coating on a substrate is provided by forming a protection layer by composite electrolytic or electroless deposition of a metal matrix M_1 containing particles of $CrAlM_2$ where M_1 is Ni or Co or both and M_2 is one or more of Y, Si, Ti, Hf, Ta or a rare earth element, forming an anchoring coat by composite electrolytic or electroless deposition of a metal matrix containing particles of a larger size than the particles of $CrAlM_2$ of the protection layer, and then spray coating a thermal barrier of a refractory material by a plasma deposition process.

The invention thus differs from that which has previously been proposed in that the protection layer and the anchoring coat are both plated rather than being flame sprayed.

The production of an M_1CrAlM_2 layer by plating has already been proposed in GB-A-2167446 where the object is to produce a coating which will, at some stage, be modified by heat treatment and that specification stresses that there should be close control of the particle size, the broadly preferred size requirement being that at least 99% by weight of the particles in the as-deposited coating are below 25 µm or at least 95% ar between 3.0 and 13.6 µm. The sp cification mentions that electrodeposition produces a coating which has a very desirable surface finish. Plating is a process which is well known to produce coatings with smooth, often shiny, surfaces and the incorporation in the deposited matrix of particles of this size still leads to relatively smooth surfaces. A thermal barrier cannot be applied directly to a spray coated MCrAlY coating with sufficient adhesion because the sprayed MCrAlY coating is insufficiently rough. A spray coated anchoring coat using coarser particles has been necessary. Consequently it would be thought that composite plating would be quite useless in providing a base for a thermal barrier. Most surprisingly, however, it has been found that a plated M_1CrAlM_2 coat followed by a plated anchoring coat with larger particles provides a most satisfactory basis on to which a thermal barrier may be applied by spray coating, with completely satisfactory adhesion between the layers. Thus the plated anchoring coat is used to produce a rough keying surface, something which is quite contrary to the normally accepted property of a plated coat which is one of smoothness.

The preferred constituents of the anchoring coat are the same as or similar to those of the protection layer since, in addition to providing an anchorage function, this coat will be subjected to similar operating conditions to those for which the underlying protection layer is provided.

The preferred constituents of and processes for applying the protection layer are those set out in the aforementioned GB-A-2167446 and for further details of apparatus and processes that may be employed reference may be made to US-A-4305792. The same apparatus and processes may be used for applying the anchoring coat.

The invention may be carried into practice in various ways but the provision of one particular overlay on a gas turbine blade will now be described by way of example.

The blade was first given a preparation treatment suitable for plating and in one example it was immersed in a cyanide cleaner for two minutes followed by a water rinse, etched by immersion for 30 seconds in a ferric chloride etch followed by a water rinse, and given a nickel strike by placing in a nickel bath for 3 minutes at a current density of 3.5 amps per square decimetre. The blade was then secured in the plating barrel described in US-A-4305792 and connected to a cathode contact. Using the techniques described in the said United States Patent the blade was given a coating to a thickness of between 0.076 and 0.127 mm of CoNiCrAlY, the bath containing a CoNi plating solution and the particles were of CrAlY containing 60 parts by weight of Cr, 40 parts Al and 1.7 parts Y. The particle size distribution was a maximum of 5% by weight below 5 µm, between 10 and 15% by weight below 10 µm and between 35 and 55% by

BNSDOCID: <EP___0288156A1_I_>

weight below 20 µm. An alternative size distribution would be a maximum of 7.7% by weight below 5 µm, 56% below 10 µm, 94% below 20 µm and 99% below 30 µm.

The blade carrying the protection layer was removed from the apparatus and washed and was then positioned in the apparatus described in GB-A-2182055 containing a similar cobalt plating solution and with the apparatus charged with CrAlY particles having the same composition as those used for the protection layer but with a different size distribution as set out below. Should a delay occur in transferring from the initial M_1CrAlY coat to the second key coat process step, the component surfaces can be reactivated by immersion in the ferric chloride etch and a nickel strike similar to the initial pretreatment. The particle size distribution is such that there is not more than 1% of the powder with a size greater than 150 µm and not more than 15% with a particle size less than 38 µm. Plating proceeded to produce an anchoring coat with a thickness of between 0.025 and 0.15 mm.

The blade was then removed and washed. The coatings were then vacuum heat treated to effect bonding of the superficial powder to the rest of the deposit. For example, the blade could be treated at 1115°C for 2 hours or at a temperature within the range 1050 to 1100°C for 2 hours or within the range 900 to 1200°C for a maximum of 2 hours at 1200°C or a minimum of 1/4 hour at 900°C. The thermal barrier was then sprayed onto the anchoring coat by a plasma flame deposition process. The coat consisted essentially of an 8% yttria stabilized zirconia having a chemical composition by weight of between 7 and 9% Y_2O_3, maxima of 1.5% SiO_2, 0.5% CaO, 0.3% MgO, 0.4% Fe_2O_3, 0.2% Al_2O_3 and 0.2% TiO_2, and the balance being ZrO_2. The particle size distribution was such that there was a maximum of 10% with a size greater than 74 µm, between 65 and 100% was above 44 µm and a maximum of 25% was below 44 µm. Instead of the vacuum heat treatment being carried out after the application of the anchoring coat, it could be carried out in the same manner after application of the thermal barrier.

As an alternative to the process described in US-A-4305792, the protective layer may be applied by the same apparatus and processes as are proposed above for applying the anchoring coat and described in the aforesaid GB-A-2182055.

During thermal cycling tests on paddle shaped specimens coated on one side by the process in accordance with the invention and described above and moved in and out of a flame to give a surface temperature rise to 1050°C in 2 minutes, and a fall in 2 minutes, the specimens satisfactorily withstood 1000 thermal cycles where the typical commercial acceptance level is 500 thermal cycles.

Claims

1. A process of producing an overlay coating on a substrate which comprises the steps of:

1) forming on said substrate a protection layer by composite electrolytic or electroless deposition of a metal matrix M_1 containing particles of $CrAlM_2$ where M_1 is Ni or Co or both and M_2 is one or more of Y, Si, Ti, Hf, Ta or a rare earth element,

2) forming on said protection layer an anchoring coat by composite electrolytic or electroless deposition of a metal matrix containing particles of a larger size than the particles of $CrAlM_2$ of the protection layer, and then

3) spray coating on said protection layer a thermal barrier of a refractory material by a plasma deposition process.

2. A process according to Claim 1 in which the particles of said anchoring coat are of the same composition as, but of larger particle size than, the particles of said protection layer.

3. A process according to Claim 1 or Claim 2 in which the size distribution of the particles in said protection layer is a maximum of 5% by weight below 5 µm, between 10 and 15% by weight below 10 µm and between 35 and 55% by weight below 20 µm.

4. A process according to Claim 3 in which said protection layer has a thickness of from 0.076 to 0.127 mm.

5. A process according to Claim 1 or Claim 2 in which the size distribution of the particles in said protection layer is a maximum of 7.7% by weight below 5 µm, 56% below 10 µm, 94% below 20 µm and 99% below 30 µm.

6. A process according to any of Claims 1 to 5 in which the size distribution of the particles in said anchoring coat is a maximum of 1% by weight above 150 µm and a maximum of 15% by weight below 38 µm.

7. A process according to Claim 6 in which the said anchoring coat has a thickness of from 0.025 to 0.15 mm.

8. A process according to any of Claims 1 to 7 wherein said thermal barrier consists essentially of yttria stabilized zirconia.

9. A process according to Claim 8 wherein the particle size distribution in the thermal barrier is a maximum of 10% by weight greater than 74 µm, between 65% and 100% abov 44 µm, and not more than 25% below 44 µm.

10. A process of producing an overlay coating on a gas turbine engine component which comprises the steps of:

BNSDOCID: <EP___0288156A1_I_>

1) preparing the surface of said component for electroplating,

2) electroplating on said surface to a depth of from 0.076 to 0.127 mm a protection layer of CoNi containing particles of CrAlY containing 60 parts by weight of Cr, 40 parts Al and 1.7 parts Y,

3) electroplating on said protection layer to a depth of from 0.025 to 0.15 mm an anchoring coat of a cobalt-containing metal matrix containing CrAlY particles having a greater particle size than those of the protection layer,

4) spray coating on said protection layer a thermal barrier of a refractory material by a plasma deposition process, and

5) after step 3, heat treating said component.

BNSDOCID: <EP___0288156A1_I_>

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EUROPEAN SEARCH REPORT

Application number

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
X	GB - A - 2 159 838 (UNITED TECHNOLOGIES CORPORATION) * Claims; page 1, lines 13-28; page 2, lines 110-130 * --	1,10	C 25 D 15/00 C 25 D 5/12 C 23 C 28/02 C 23 C 18/32
D,X	GB - A - 2 167 446 (BAJ LIMITED) * Claims; page 1, lines 1-19 * ----	1,10	

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

C 25 D
C 23 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	24-06-1988	PAMMINGER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing dat
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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